SEE Testing of the RH1013 Dual Precision Operational Amplifier

Ray Ladbury (NASA/GSFC)
&
Stephen Buchner (QSS Group Inc)

Texas A&M Cyclotron Facility
December 2005

Introduction

The RH1013, manufactured by Linear Technology, was tested for Single Event Effects (SEEs) at Texas A&M Cyclotron Facility (TAMU) in December 2005. The RH1013 consists of two operational amplifiers in a 10-pin flatpack. The part is expected to be sensitive to single event transients (SETs). The object of the test was to determine the maximum amplitude and width of the SETs.

Part Identification

One part was tested. The following identification information is on the lid:

RH1013
Q 0343A

Figure 1 shows the connections to the RH1013.

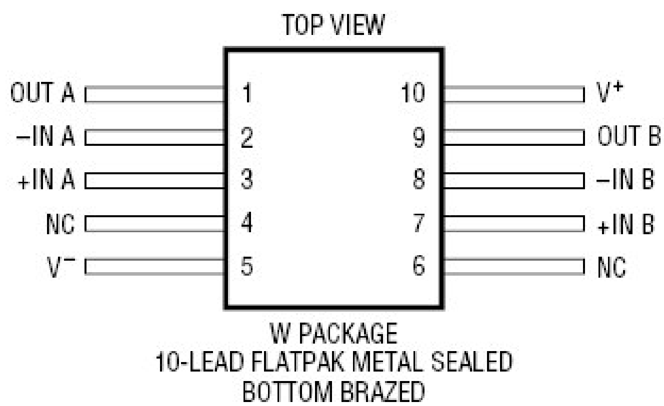

Fig. 1. Pinout for the RH1013

Test Method

One part was de-lidded and mounted on a board. One of the two op-amps (a) was connected with a gain of 10. The other (b) was configured as either a voltage follower or an amplifier with gain of 2 using a jumper. The supply was +/- 15V. The part was located in front of the exit port of the accelerator and was controlled remotely through a LAN.

Both positive and negative transients were captured on an oscilloscope (11 pF) oscilloscope probes to the output (Pin 1) of the RH1013. The trigger levels were set at +100 mV and –100 mV.

Ions Used

Ion	Energy (MeV)	LET (MeV.cm^2/mg)
Ar	15	8.57
Kr	15	28.8
Xe	15	53.1

Results

The captured transients had a variety of amplitudes and widths. Fig. 2 is a plot of amplitude vs width at an effective LET of 75 MeV.cm^2/mg obtained by rotating the device so that the ion beam was incident at an angle of 45^o. There are both positive and negative transients when the input is 0.5 V. The longest transients had widths of < 5 µs. Fig. 3 shows the same plot for transients produced by ions with LET of 53.1 MeV.cm^2/mg. All those transients had widths less than 1 µs. Fig. 4 shows the SET cross-section as a function of effective LET for transients with amplitudes larger than +/-100 mV. Fig. 3 and Fig. 4 show the same data for different configurations.

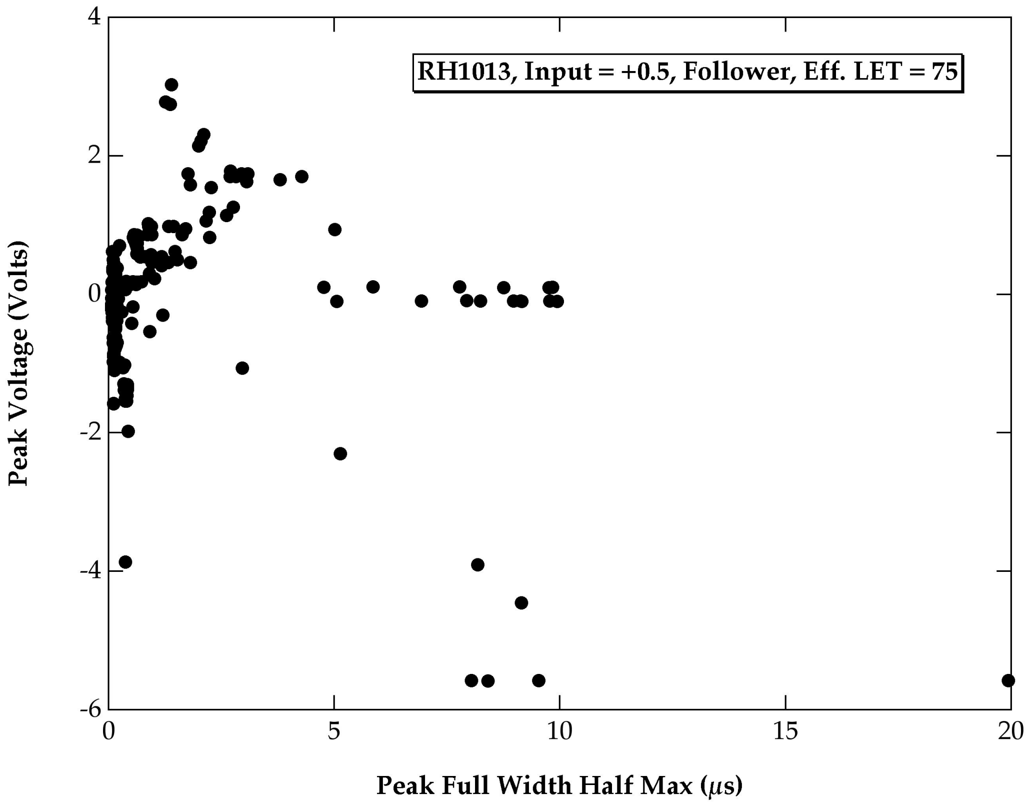

Fig. 2. Plot of amplitude vs width for the RH1013 configured as a voltage follower and exposed to 15 MeV Xe ions (LET of 75 MeV.cm^2/mg at 45^o). The largest transients have amplitudes of –6V and widths of 20 µs.

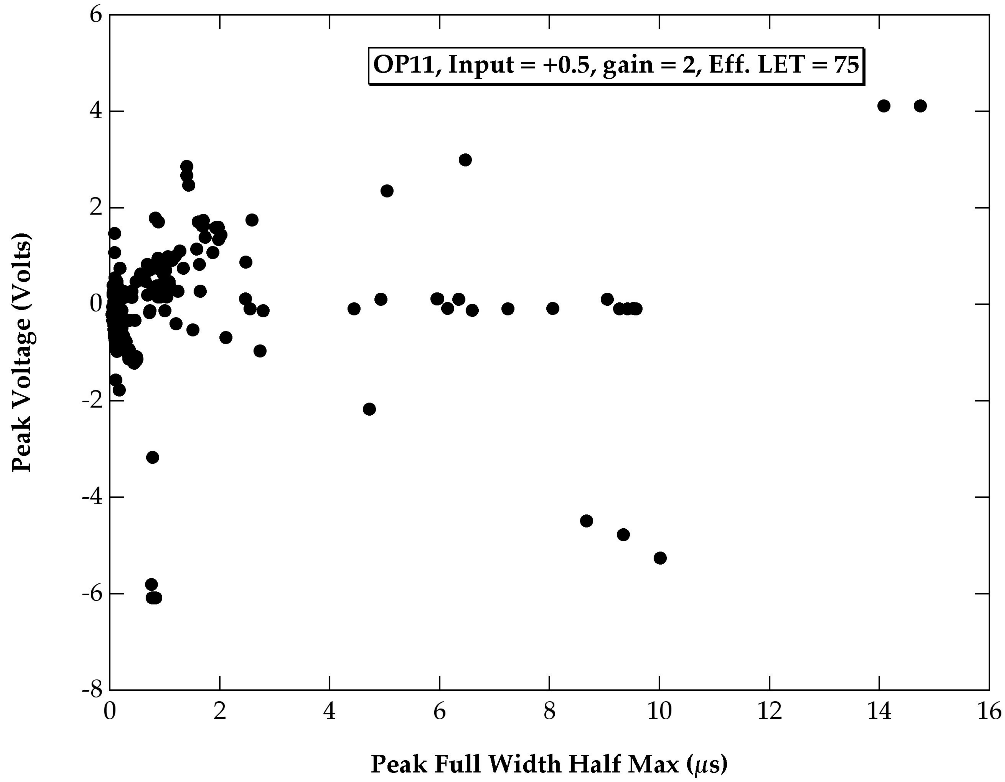

Fig. 3. Plot of amplitude vs width for transients in the RH1013 configured as an amplifier with gain of 2. The ions were 15 MeV Xe ions (Effective LET = 75 MeV.cm^2/mg at 45^o). The largest transients had amplitudes of 4 V and widths of 15 μ s.

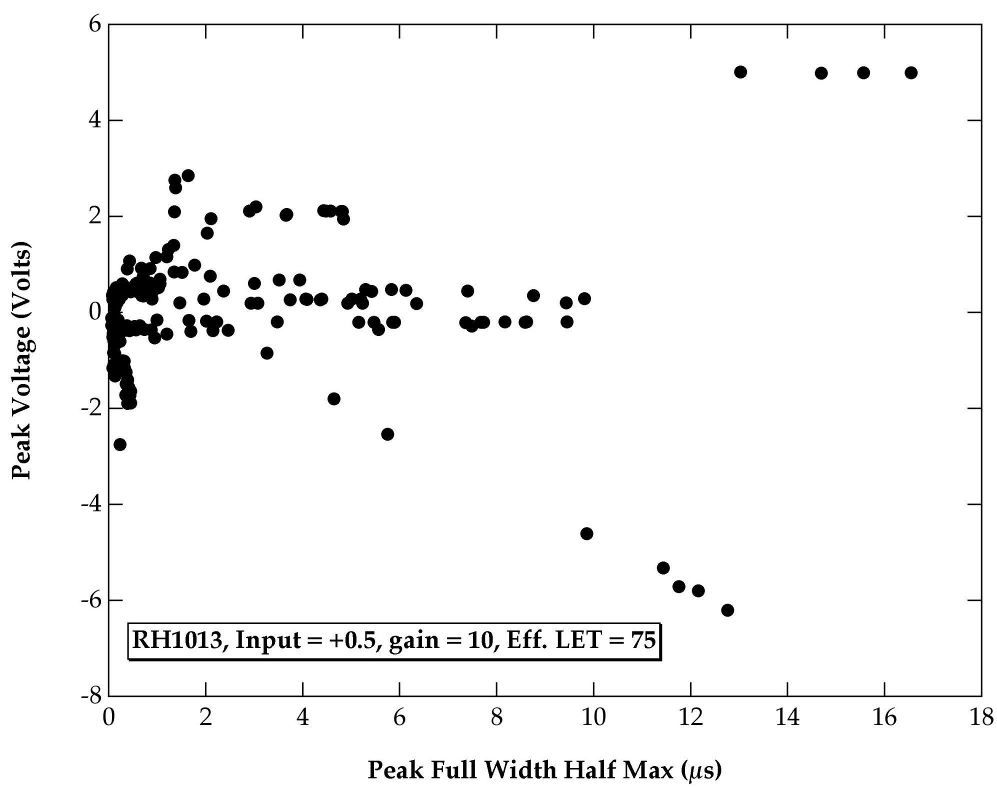

Fig. 4. Plot of amplitude vs width for SETs produced with 15 MeV Xe ions (LET = 75 MeV.cm^2/mg at 45^o). The longest transients had amplitudes of +5V and widths of 17 μs.

The cross-section was also calculated for the different gains. They are displayed in Figs. 5, 6, and 7.

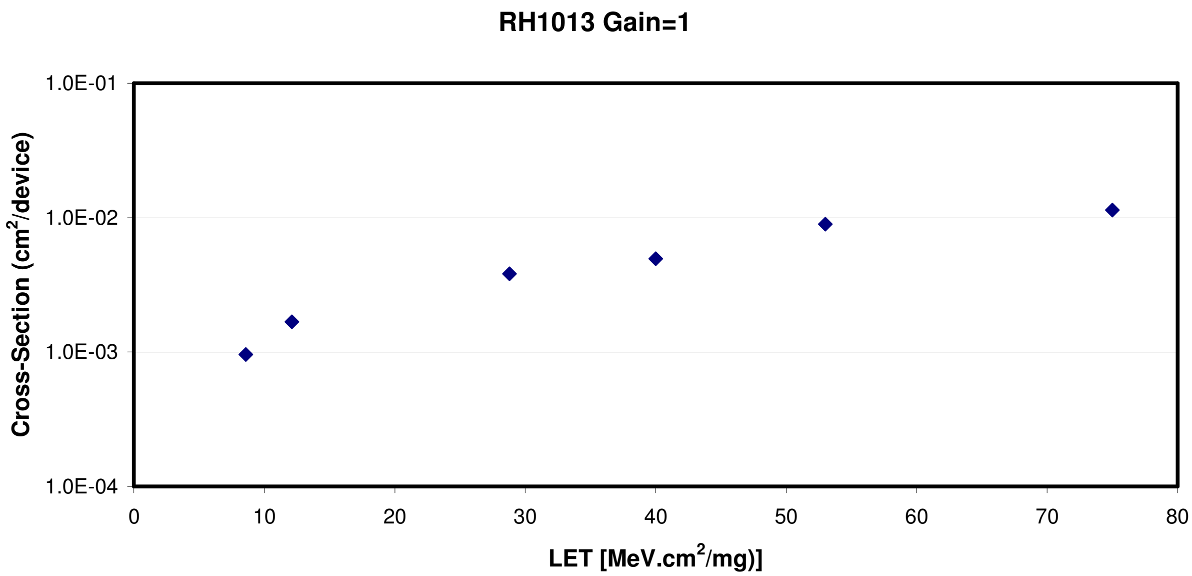

Fig. 5. Plot of Transient Cross-Section vs LET for Gain=1.

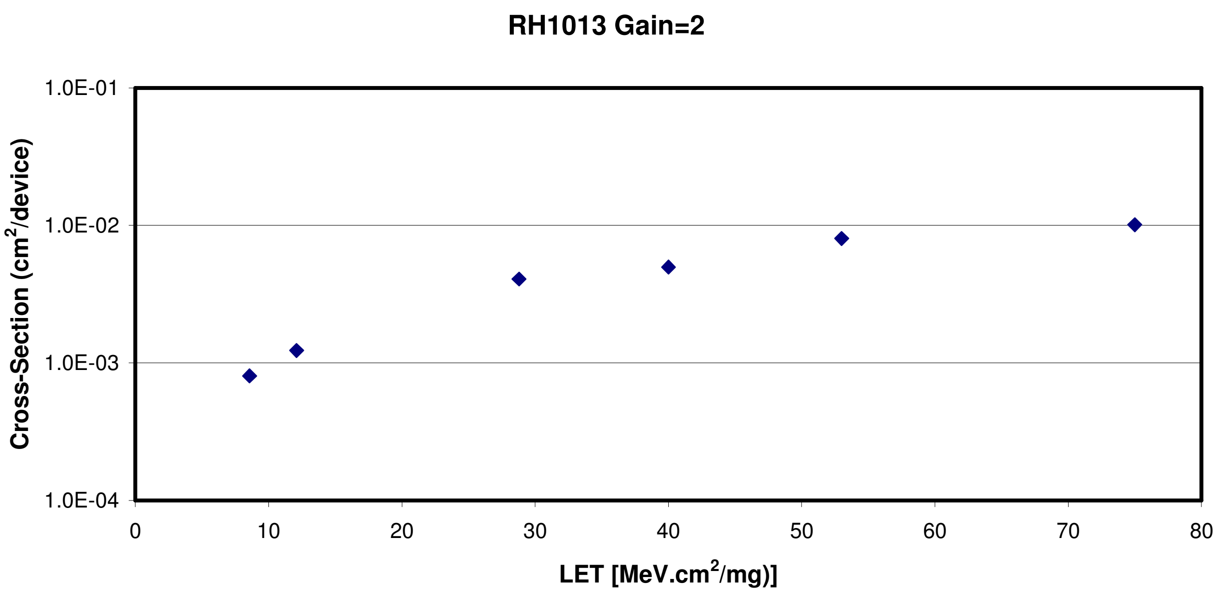

Fig. 6. Plot of Transient Cross-Section vs LET for Gain=2.

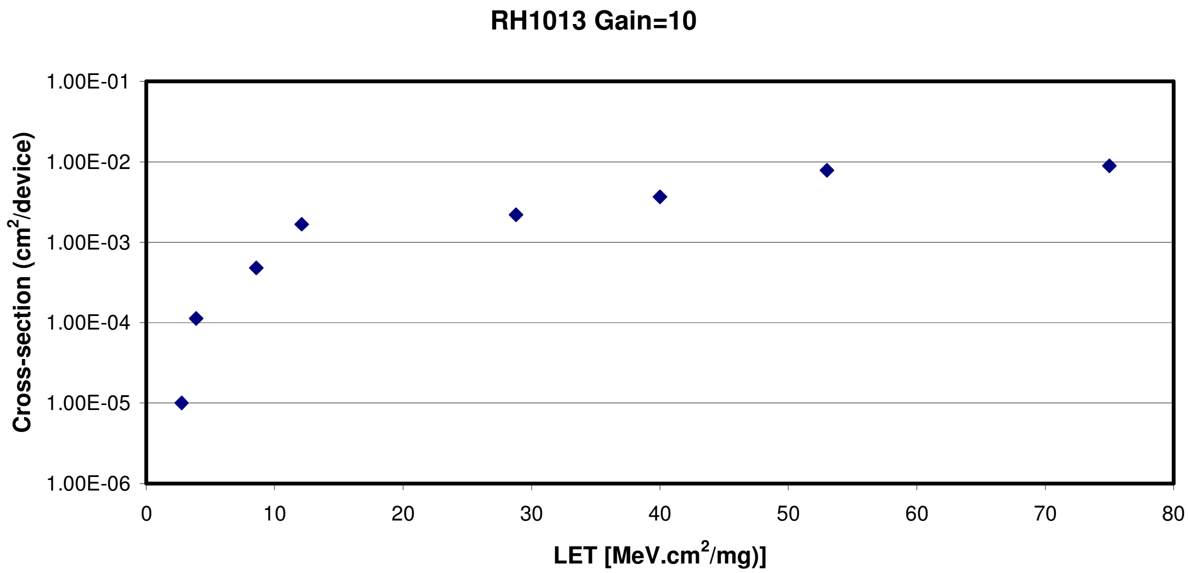

Fig. 7. Plot of Transient Cross-Section vs LET for Gain=10.

No destructive single event effects occurred up to a LET of 75 MeV.cm^2/mg. Also, no latchup was observed.

Category

In general, devices are categorized based on heavy ion test data into one of the four following categories:

Category 1 – Recommended for use in all NASA/GSFC spaceflight applications.
Category 2 – Recommended for use in NASA/GSFC spaceflight applications, but may require mitigation techniques.
Category 3 – Recommended for use in some NASA/GSFC spaceflight applications, but requires extensive mitigation techniques or hard failure recovery mode.
Category 4 – Not recommended for use in any NASA/GSFC spaceflight applications.

Based on results of proton testing and previous heavy ion data, this part is assigned to category 2.